AN ASSESSMENT OF PESTICIDE RESEARCH PROJECTS FUNDED BY THE MINISTRY OF THE ENVIRONMENT THROUGH THE ONTARIO PESTICIDES ADVISORY COMMITTEE 1973 - 1974

Restricted to internal use

Ontario Pesticides Advisory Committee

Ministry of the Environment

Ontario

The Honourable
William G. Newman,
Minister

Everett Biggs,
Deputy Minister

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TABLE OF CONTENTS

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RESEARCH PROJECT FUNDED THROUGH THE ONTARIO PESTICIDES ADVISORY COMMITTEE, 1973 - 74.

I SUMMARY

1) In 1973-74 the Ontario Pesticides Advisory Committee established a research program with three major objectives:

   a) To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

   b) To determine potential environmental hazards with pesticides presently in use.

   c) To reduce total pesticide input into the environment.

2) Forty-two applications for research grants totalling $560,529 were received.

3) Fourteen grants totalling $100,000 were awarded.

4) Several effective alternative insecticides were tested for cutworm control in minor vegetable crops with one insecticide now being registered for use.

5) A study of the biting fly problem in Ontario was initiated.

6) Eight studies were initiated to determine the effects of pesticides presently in use on non-target soil organisms; on plants; on aquatic organisms; and on wildlife. Some effects were noted.

7) Four programs aimed at reduction of pesticide input into the environment were begun involving development of effective pest monitoring techniques, better application techniques, and alternatives non-chemical methods of pest control. Promising results were obtained.

8) The Advisory Committee is satisfied that in general the research done was of high calibre.

II RECOMMENDATIONS

1) The Advisory Committee recommends that funds be made available to the Committee to continue the program of grants for pesticide research.

2) That funds in the amount of $150,000.00 be made available for the program in 1975-76.

3) That the Committee continue its supervision of the Ministry's pesticide research.

II Review of the research program

In 1973-74 the Ontario Pesticides Advisory Committee was allocated $100,000. to sponsor research that would lead to reduction in the overall use of pesticides and to find alternates for those pesticides deemed to be an environmental hazard. The funds were granted on relatively short notice (February, 1973) and since pesticide studies involving field work often begin in late April or early May, it was necessary for the Committee to act rapidly in order to insure that the funds would be well utilized. Since there was no time to set up a formal mechanism for consideration of applications for grants, the entire Committee determined the terms of reference to be used in inviting grant applications, reviewed all applications received and then decided on grants to be awarded during a special one day meeting.

The terms of reference for research to be sponsored by the Committee (APPENDIX I) were primarily based on three Committee objectives. First, the Committee is well aware that restrictions by the Government on pesticide use in Ontario (often on recommendation of the Committee) have resulted in some problems when effective replacement materials are not readily available. Secondly, the Committee feels that data available on potential environmental hazards associated with pesticides presently in use is inadequate. Thirdly, it is convinced that the most effective approach to the problem of environmental pollution with pesticides is to reduce total pesticide input into the environment. The "Call for Grant Requests" based on these three objectives therefore emphasized studies involving: 1) research leading to registration of environmentally acceptable pesticides especially for use on minor crops (Objective 1); 2) studies on the fate and persistence of pesticides presently in use,in the environment; and on their effects on non-target organisms (Objective 2); and 3) studies on economic threshholds of pests; improved application techniques; and non-chemical approaches to pest control (Objective 3). Invitations for grant applications were sent out in February, 1973 to universities, industry, and government (APPENDIX II), with the deadline for applications on March 10, 1973. Decisions on grants to be awarded were made by April 1.

Response to the request for applications was very good. Forty-two applications for grants were received requesting a total of $560,529. (APPENDIX III). Applications were primarily from university faculty (38) but four were received from industry. The thirty-eight university applications came from Carleton, Guelph, Lakehead, Laurentian, McMaster, Ottawa, Queen's, Toronto, Waterloo, Western, and York. Requests for funds, of course, far exceeded the amount available to the Advisory Committee.

After receiving the applications the Committee awarded twelve grants totalling $81,395 (APPENDIX IV), holding back $18,605 as a reserve fund for use should problems meriting research support develop during the 1973-74 fiscal year. Some of the remaining twenty-six applications would have merited support with revision

and if more funding had been available. Provision of the reserve fund proved to be a wise decision in that two problems arose during the year which merited research support and the total reserve fund was committed to these programs. Thus the $100,000 research fund was distributed in a total of 14 research grants averaging $7,143 and ranging from a low of $2,500 to a high of $18,000.

It rapidly became apparent that it would be unwieldy for the entire Pesticides Advisory Committee to attempt to administer the grant program and a research subcommittee was created, with membership comprising primarily research-oriented members of the Advisory committee. Subcommittee members were: Dr. D. A. Chant, Dr. R. Frank, Dr. K. G. Laver, Dr. F. L. McEwen, Mr. J. H. Neil, Dr. G. R. Stephenson, and Dr. C. R. Harris (Chairman).

Progress of the research program was monitored throughout the year in two ways. In late December and early January two half days coinciding with regular Advisory Committee meetings were set aside for seminars by the recipients of grants. This approach was found to be highly successful. It enabled Advisory Committee members to become familiar with the recipients of grants and their research, and to offer constructive suggestions. Those holding grants were equally enthusiastic in that they had an opportunity not only to present their own results but to meet with and hear of results obtained by others. A few were unable to attend these seminars; these individuals were visited at least once during the year by some members of the research subcommittee. In addition to the seminar programs, each recipient of a grant was requested to submit a progress report by the end of March, 1974, including an Abstract of the work.

Abstracts of the fourteen research projects are included in this report (APPENDIX V) and will be summarized only briefly here in relation to the objectives outlined above:

> Objective 1. To find effective alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

In general effective alternative insecticides were available for most insect pests when organochlorine insecticide use was restricted in Ontario in 1969 and 1970. However there were no effective alternatives for cutworm control. Cutworms are omnivorous pests which attack a wide variety of crops. Research by federal, provincial, and university personnel led to registration of effective replacement materials on major crops such as tobacco and some important vegetable crops between 1970-73. However minor crops, particularly vegetables grown in mineral soil were neglected. A small grant provided by the Advisory Committee provided the stimulus for a very extensive research program on cutworm control on minor vegetable crops involving both federal and provincial personnel. As a result of this work one new insecticide has received a temporary registration in 1974, and submission for registration of another is being prepared. A similar situation exists with regard to

biting fly control. While such rapid resolution of this problem cannot be expected a grant was negotiated on the initiative of the Advisory Committee with the Universities of Waterloo and Guelph to review the entire biting fly problem and to make specific recommendations on how this problem should be approached in Ontario. The Advisory Committee is particularly pleased that it was able to negotiate a joint grant between the two universities thus utilizing expert staff available at both locations.

Objective 2: To determine potential environmental hazards with pesticides presently in use.

Eight of the fourteen research grants allocated by the Advisory Committee related to this objective. Studies on the persistence and degradation of a series of s-triazine herbicides indicated that most were detoxified chemically in the environment by chemical hydroxylation of the 2 carbons of the ring. In the case of cyanazine chemical transformation occurs at the cyano-group of the 4-carbon constituent. However in soils, microbial rather than chemical degradation was the main mechanism of detoxification and a number of degradation products resulting from microbial transformation were identified. A second study indicated that the dipyridyl herbicide, paraquat, was degraded both chemically and biologically in soils under aerobic or anaerobic conditions. In addition to chemical and microbial degradation of pesticides in soil, volatilization is also an important pathway of degradation. A preliminary study was initiated to design an apparatus capable of determining evaporation rates of insecticides under simulated environmental conditions, and evaporation rates were obtained for parathion and diazinon.

Studies on the effects of herbicides on non-target soil microorganisms indicated that the triazine herbicides did not inhibit mineralization of carbon or nitrogen or the biological transformation of ammonium nitrogen to nitrate nitrogen in soil. The dipyridyl herbicides paraquat and diquat had inhibitory effects on straw degradation and cellulose degradation processes. Paraquat inhibited asymbiotic N_2-fixation in soil and symbiotic N_2-fixing bacteria in pure culture as well as some other soil bacteria. Studies on the systemic insecticide, carbofuran indicated that this compound has a stimulatory effect on root growth of plants using corn and radish seedlings as indicator organisms. Widespread use of materials such as the phenoxy herbicides can often result in damage to non-target vegetation via spray drift. A study was conducted to compare the effectiveness of various chemicals and nozzle types for the reduction of spray drift under actual field conditions, and to test so-called "drift reducing agents" presently on the market. The results of this study indicated that: 1) detectable drift of 2,4-D applied in a normal fashion occurred at significant distances from the point of application; 2) some nozzle types gave more drift than others; 3) the addition of a thickening agent did not greatly reduce drift; 4) less drift occurred using a foam treatment.

Several of the research programs involved studies on the effects of pesticides on the aquatic ecosystem. The s-triazine herbicides had no significant effects on microbial processes in aqueous systems. The dipyridyl herbicides broke down slowly in water and sediment and bacteria isolated from the system showed variable responses to different concentrations of diquat. Studies on the insecticides Abate and Dursban used for biting fly control indicated that, at relatively high concentrations, they influenced microbial numbers and processes. Some preliminary data was obtained which indicated that the triazine herbicides inhibited the fixation of nitrogen by blue green algae, and laboratory and field studies indicated that Dursban could have an effect at low concentrations on several types of phytoplankton.

At the instigation of the Advisory Committee a study was initiated to determine whether wild birds would eat granular formulations of pesticides. Progress was made in developing a marker which could be used for incorporation into granules to allow tracing of granular consumption by either caged or free ranging birds.

Objective 3: To reduce total pesticide input into the environment.

In the long term reduction of pesticide input into the environment, while at the same time achieving as or more effective pest control, should be the major goal of any pesticide research program. Research in a number of areas would help to achieve this goal e.g. determination of economic levels of crop damage; development of effective pest monitoring techniques; of more efficient methods of application; and development of alternative non-chemical approaches to pest control. Four research grants were allocated within this general objective.

Good progress was made on a study involving reduction of the number of fungicide applications required to suppress carrot leaf blights by scheduling sprays according to weather data. A very complete set of field data was obtained which indicated that by timing sprays to weather conditions rather than following a preventative program, the total number of sprays applied could be reduced from 7 to 3. Work was also initiated on developing a technique for electrostatic application of pesticides with the aim of providing more effective coverage while at the same time reducing drift resulting in accidental environmental contamination. Promising results were obtained in laboratory and field tests which indicated that electrified particles achieve a better coverage on both sides of the leaf.

A major research program on control of the onion maggot using the sterile male technique was supported through an Advisory Committee grant. Large quantities of insecticides are presently used to control the onion maggot using both soil applications for larval control in the first generation and numerous (up to 18 or 19) adulticide sprays for control of the 2nd and 3rd generations. Evidence has been obtained which indicates: a) that the onion maggot is becoming tolerant to organophosphorus and carbamate insecticides; and b) that residues of these insecticides are accumulating in soils and adjacent drainage canals and streams. The

biology of the onion maggot appears to meet the requirements necessary for successful application of the sterile male technique. A successful mass rearing technique has been developed. Laboratory studies indicated that pupae could successfully survive Cobalt-60 irradiation and that sterilized males were competitive in cage experiments with normal males. Cage experiments also indicated that a 9:1 flooding ratio should result in 90% reduction in egg hatch. A white-eyed mutant strain was used in field studies to serve as a marker strain. While laboratory tests had indicated that this strain was competitive with the normal red-eyed strain, field studies indicated that the white-eyed adults were not as mobile as the red-eyed strain and thus not competitive. Nevertheless, in a small release program in the Holland Marsh using the white-eyed strain, egg fertility was reduced by about 20%.

Pesticides are widely used and often misused by homeowners. While alternative methods of pest control are not always economically feasible in agriculture, they can be of use in home gardens. A grant was therefore awarded to determine effective alternative methods to chemical control in home gardens. These results indicated that effective pest control can be achieved with minimum pesticide use in home gardens, providing the homeowner is willing to put a little more labour into his gardening program. The study also demonstrated that some of the more exotic techniques advocated by "organic gardeners" such as companion plantings, herbal sprays, and light traps were not particularly effective.

In assessing the first year of this program, the Advisory Committee feels that the value of the research completed far exceeds the $100,000 investment. Productivity of a few investigators was disappointing but the productivity of the majority far exceeded our expectations. It is our feeling that this remarkable productivity is due to 3 factors: 1) that the program was sufficiently small that the Advisory Committee was able to negotiate directly with those applying for grants, to advise them on appropriate modifications, and to monitor the work through the year; 2) that by strategically placing small grants, it was able to stimulate initiation of much larger projects by other agencies both provincial and federal; and 3) that it was able to utilize expert personnel at different universities by negotiating joint grants. To maintain this type of flexibility, the research program of the Advisory Committee should be kept small. Nevertheless several good grant applications fitting within our objective were denied in 1973-74; and others were pared down drastically. The Committee suggests that an increase in the ceiling from $100,000 to $150,000/year would provide more flexibility in funding worthwhile projects. This level of funding would still be manageable from the Committee's point-of-view without affecting the high quality of the research program.

APPENDIX I. Format of advertisement inviting applications for research grants from the Ontario Pesticide Advisory Committee, 1973-74

CALL FOR GRANT REQUESTS

The Ontario Ministry of the Environment has a limited amount of funds available to sponsor research that will reduce the overall use of pesticides and find alternates for those that are environmentally hazardous. Funds will be made available on the basis of a negotiated contract for specific research projects. Preference will be given to proposals that will yield results in a relatively short time (less than three years), and funds will be committed on a one-year basis. Research should be in the context of normal use patterns.

The Ministry invites proposals in the following areas:

1. The economics of pest control including economic threshholds of pests.
2. Research on specific non-chemical approaches to pest control.
3. Reduction of pesticide usage through improved application techniques.
4. Research leading to the registration of environmentally acceptable pesticides, especially for use on minor crops such as lettuce, peppers, asparagus, etc.
5. Effects of insecticides, fungicides, and/or herbicides or non-target organisms including research on drift control during pesticide application and movement of pesticides in the environment.
6. Studies on the fate and persistence of pesticides in the environment with particular reference to parathion, carbofuran, chlordane and its metabolites.

Application Procedure

Research proposals should be submitted to:

The Chairman,
Pesticides Advisory Committee,
Ontario Ministry of the Environment,
Fifth Floor, Mowat Block, Queen's Park,
Toronto, Ontario. M7A 1A2

Applications should include the following:

1. Title of project.
2. Name, address and affiliation of applicant.
3. Discussion of problem.
4. Clear statement of objectives.
5. Plan for the program.
6. Facilities available to the researcher for the conduct of the program.
7. Budget: categorize costs as: Personnel, full-time and part-time; equipment, supplies, other.
8. Curriculum vitae on principal investigator.

Applications should be received by March 10, 1973.

APPENDIX II. "Call For Research Grants": Mailing List, 1973-74

BROWN, Mr. Chris., Senior Project Development Officer, Proj. Dev. Dept., Ontario Research Foundation, Sheridan Park, Mississauga (Clarkson),Ont.

BUTLER, Mr. J., New Liskeard College of Agricultural Technology, New Liskeard, Ont.

CANADA WEED COMMITTEE, (The Chairman), Box 440, Regina, Saskatchewan.

CHAPPEL, Dr. Clifford I., Bio-Research Labs., 265 Hymus Blvd., Point Claire, Montreal, Quebec.

CHEVALIER, Mr. Jacques, Executive Secretary, Canadian Agricultural Chemicals Association, Suite 710, 116 Albert Street, Ottawa, Ontario K1P 5G3.

COLLIE, Prof. M. J., Dean of Graduate Studies, York University, 4700 Keele St., Downsview, Ontario.

CROWLEY, The Rev. C. P., C.S.B., Dean, Graduate Studies, University of Windsor, Windsor 11, Ontario.

De La IGLESIA, Mr. Phoenix, Warner Lambert Research Labs., Sheridan Park, Mississauga (Clarkson), Ontario.

D'IORIO, Dr. Antoine, Dean, Faculty of Science & Engineering, University of Ottawa, Ottawa, Ontario.

DYMOND, Miss Sidney, Research Administration, University of Toronto, Toronto, Ont.

FRENCH, Dr. Ian, President, Nucro-Technics Ltd., 2000 Ellesmere Road, Unit 16, Scarborough 722, Ontario.

GRAHAM, Dr. R. P., Dean of Science Studies, McMaster University, Hamilton, Ont.

HIKICHI, Mr. A., Ontario Ministry of Agriculture & Food, Research Station, P.O. Box 246, Simcoe, Ontario.

MacDONALD, Mr. G., Principal, Centralia College of Agricultural Technology, Centralia, Ontario.

MacKAY, Mr. Don., Chemical Engineering Department, University of Toronto, 200 College Street, Toronto 181, Ontario.

McINTOSH, Dr. R. L., Dean, Graduate Studies, Queen's University, Kingston, Ont.

NASH, Dr. Peter H., Dean, Division of Environmental Studies, University of Waterloo, Ontario.

NESBITT, Prof. H. H. J., Dean, Faculty of Science, Tory Science Building, Carleton University, Ottawa, Ontario.

ONTARIO RESEARCH FOUNDATION, Sheridan Park, Mississauga (Clarkson), Ont.

PASIKA, Dr. W. M., Dean, Science Faculty, Laurentian University, Sudbury, Ont.

PEARSON, Dr. W. B., Dean, Faculty of Science, University of Waterloo, Waterloo, Ont.

PITMAN, Prof. W. G., Dean, Arts & Science, Trent University, Peterborough, Ont.

PLINT, Dr. Colin A., Dean of Graduate Studies & Dean of Arts & Science, Brock University, St. Catharines, Ontario.

RAINFORTH, Mr. Jim, Associate Director, Soils & Crops Branch, Ontario Ministry of Agriculture & Food, Vineland Research Station, Vineland, Ontario.

REYNOLDS, Mr. L., Ontario Research Foundation, Sheridan Park, Mississauga (Clarkson), Ont.

ROSS, Dr. R. A., Dean, Faculty of Science, Lakehead University, Thunder Bay, Ont.

SNOW, Mr. W., Principal, Ridgetown College of Agricultural Technology, Ridgetown, Ont.

STEWART, Dr. H. B., Dean of Graduate Studies, University of Western Ontario, London, Ontario.

STINSON, Mr. F., Principal, Kemptville College of Agricultural Technology, Kemptville, Ontario.

SWITZER, Dr. C. M., Chairman, Research Planning Committee, Canada Weed Committee Eastern Section, c/o O.A.C., University of Guelph, Guelph, Ontario.

TOSSELL, Prof. W. M., Dean of Research, University of Guelph, Guelph, Ontario.

WAGNER, Dr. Norman, Director of Graduate Studies & Research, Waterloo Lutheran University, Waterloo, Ontario.

WEBSTER, Mrs. Muriel B., Ontario Food Processors Association, Ontario Food Terminal, Room 309, 165 The Queensway, Toronto 560, Ontario.

APPENDIX III. Research proposals submitted to the Ontario Pesticide Advisory Committee, 1973-74

No.	Applicant(s)	Location	Project Title	Amount requested
1	Alex, J. F.	University of Guelph	Biological control of perennial spurges.	$ 8,575.
2	Baarschers, W. H.	Lakehead University	The biochemistry of insect-plant inter-relationships.	8,300.
3	Bandeen, J. D.	University of Guelph	Economic threshhold level of certain weed species in field corn.	20,308.
4	Barlow, C. A.	Carleton University	Economic levels of insect pest attack on pea and forage crops and the efficiency of biological control agents.	12,867.
5	Boyer, M., Coleman, B., Fowle, C. D., and J. S. Tait.	York University	Effects of mosquito larvicides on the population structure, diversity, and productivity of fresh water ponds	20,800.
6	Brown, J. R.	University of Toronto	The effect of Dursban when applied in the form of a larvicide preparation upon the microflora intake in bottom sediments and uptake in fish in natural bodies of water and the determination of the persistence of this material and its seasonal change in concentration.	24,460.
7	Bunting, J. W.	University of Toronto	Chemistry and biochemistry of herbicidal nitrogen heterocycles.	16,120.
8	Chadwick, J. M. and P. Faulkner	Queen's University	The utilization of insect polyhedrosis viruses as an alternative to chemical pesticides: studies on the viral factors which contribute to the host range of susceptible insects and an investigation of an acquired immunity of insects to viruses.	14,850
9	Chefurka, P.	University of Western Ontario	Structural interactions between toxaphores and membrane lipids as a guide for the synthesis of new pesticides.	10,200.
10	Corbet, P. S., Smith, S. Downer, R. G., and R. Wright	University of Waterloo and University of Guelph	Mosquito control in Ontario	15,065.

No.	Applicant(s)	Location	Project Title	Amount requested
11	Corke, C. T.	University of Guelph	Interactions of triazine herbicides with soil and freshwater environments.	$ 8,990.
12	Downe, A. E. R.	Queen's University	The development and evaluation of procedures for autocidal control of insect pests.	9,400.
13	Downer, R. G., Smith, S. M., and J. E. Thompson	University of Waterloo	Environmentally acceptable methods for the suppression of biting flies in Ontario.	32,933.
14	Fenton, M. B.	Carleton University	Further studies on the non-chemical control of populations of bats in buildings.	4,400.
15	Fletcher, R. A. and C. R. Ellis	University of Guelph	Effect of carbofuran on the physiology of the plant and simultaneous use of herbicides and insecticides in pest and weed control.	10,885.
16	Fowle, C. D.	York University	Potential hazards to birds from granular formulations of pesticides.	3,000.
17	French, I. W.	Nucro-Technics Ltd.	Outline of Nucro-Technics capabilities, major equipment and personnel available to subcontract work or projects.	Nil
18	Frost, R. A.	University of Toronto	Reduction in herbicide use through advanced prediction of weed infestations.	12,851.
19	George, J. A.	University of Western Ontario	Production and reception of pheromones of the oriental fruit moth, *Grapholitha molesta*.	7,400.
20	Gibo, D.	University of Toronto	Techniques for increasing populations of predatory social wasps for biological control.	5,200.
21	Gillespie, T. J. and J. C. Sutton	University of Guelph	Reduction of fungicide usage on vegetable crops by scheduling sprays according to weather data.	9,322.
22	Harmsen, R.	Queen's University	The application of systems modelling to crop-pest population forecasting.	15,000.
23	Holsworth, W. N.	University of Western Ontario	Transfer of mercury from golf course greens to the ecosystem.	2,500.
24	Hubbes, M.	University of Toronto	Biological control of Dutch elm disease	26,000.
25	Hutchinson, T. C.	University of Toronto	A study of heavy metal retention in soils and their uptake by crops as a result of pesticide applications.	10,790.

No.	Applicant(s)	Location	Project Title	Amount requested
26	Inculet, I. I, W. H. Wilde, and G.S.P. Castle	University of Western Ontario	Electrostatic application of pesticides in orchards and field crops.	$ 11,100
27	Iglesia de la, F. A.	Warner-Lambert Research Institute	To develop a research plan aimed to investigate the biological effects of a selected group of chemical agents at different levels of biological organization with an interdisciplinary approach.	NIL
28	Kay, B. D. and J. W. Ketcheson	University of Guelph	Herbicide movement in soil	9,360.
29	Kaye, B. H. and A. G. Naylor	Laurentian University	Reduction of crop pesticide dosage through improved application technique.	10,000.
30	Knerer, G.	University of Toronto	The insecticidal effects of phytohormones and other compounds in the leaves of balsam fir on the development and survival of diprionid sawfly larvae.	5,200.
31	Last, A. J.	Ontario Research Foundation	Control of pesticide drift by close sizing of liquid spray particles using ultrasonic and other specialized spray techniques.	48,700.
32	MacKay, D.	University of Toronto	Studies on the rate of evaporation of pesticides.	5,746.
33	Mahaney, W. C.	York University	Effect of deep tillage and soil pollutants on gray-brown podzolic soils in southern Ontario.	34,505.
34	Mayfield, C. I.	University of Waterloo	Effects of the dipyridyl herbicides paraquat and diquat on non-target organisms.	15,665.
35	McEwen, F. L.	University of Guelph	Control of the onion maggot, Hylemya antiqua (Meigen), by use of the sterile male technique.	27,069.
36	Meresz, O.	University of Toronto	Selective control of insect species - synthesis of potential insect attractants.	17,680.
37	Ontario Fruit and Vegetable Grower's Association	Toronto	To register spray compounds for control of the dark sided cutworm, Euxoa messoria (Harris) on cucumbers, potatoes, tomatoes, and peppers grown on mineral soil.	2,500.

APPENDIX III. (continued)

No.	Applicant(s)	Location	Project Title	Amount requested
38	Orlob, G. B.	University of Toronto	Alternative methods to chemical control in the home garden.	$ 7,053.
39	Patrick, A. Z.	University of Toronto	Direct parasitism of Thielaviopsis basicala and other soil inhabiting plant pathogens by microorganisms.	5,850.
40	Phillips, C. A.	University of Toronto	Atmospheric fate of pesticides.	17,700.
41	Snieckus, V.	University of Waterloo	Studies on the chemical basis of host plant selection by the cabbage root fly, Hylemya brassicae Bouche.	12,805.
42	Spencer, D. I.	McMaster University	Application of radioactive tracer methods to a study of the metabolic fate of pesticides in plant and animal tissues.	19,700.
43	Stephenson, G. R. and G. W. Anderson	University of Guelph	Reduction of herbicidal drift in roadside spraying and application of 2,4-D in cereal crops.	13,745.
44	Wienberger, P.	University of Ottawa	The fate and persistence of pesticides in the environment with special reference to fenithrothion, methyl parathion, and parathion: effect on growth and development of economically important tree seeds and seedlings.	4,000.

Total research funds requested in 1973-74 $ 578,594.

Total research funds allocated to the Ontario Pesticide Advisory Committee in 1973-74 100,000.

APPENDIX IV. Research grants allocated by the Ontario Pesticides Advisory Committee, 1973-74

No.	Applicant(s)	Location	Project Title	Amount granted
1	Boyer, M. G. and C. D. Fowle	York University	The response of bacteria, algae and invertebrates in small ponds to applications of mosquito larvicides.	$ 7,800.
2	Brown, J. R.	University of Toronto	The effect of 0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate (Dursban) on aquatic microflora.	5,000.
3	Corbet, P. S., S. Smith, R. G. Downer and R. Wright	University of Waterloo and University of Guelph	Mosquito control in Ontario	15,605
4	Corke, C. T.	University of Guelph	Interactions of triazine herbicides with soil and fresh water environments.	7,500.
5	Fletcher, R. A.	University of Guelph	Effect of carbofuran on the physiology of plants.	5,000.
6	Fowle, C. D.	York University	Potential hazard to birds from granular formulations of pesticides.	3,000.
7	Gillespie, T. J. and J. C. Sutton	University of Guelph	Reduction of fungicide usage in vegetable crops by scheduling sprays according to weather data.	7,175.
8	Inculet, I. I.	University of Western Ontario	Electrostatic application of pesticides in orchards and field crops.	5,000.
9	MacKay, D.	University of Toronto	Studies on the rate of evaporation of pesticides, particularly diazinon and parathion, under Ontario climatic conditions.	4,420.
10	Mayfield, C. I.	University of Waterloo	Effects of the dipyridyl herbicides paraquat and diquat on non-target organisms.	5,000.

APPENDIX IV (continued)

No.	Applicant(s)	Location	Project Title	Amount granted
11	McEwen, F. L.	University of Guelph	Control of the onion maggot, *Hylemya antiqua* (Meigen) by use of the sterile male technique.	$ 18,000.
12	Ontario Fruit and Vegetable Grower's Association	Toronto	To develop data for registration of compounds for the control of cutworms on horticultural crops grown in mineral soils.	2,500.
13.	Orlob, G. B.	University of Toronto	Alternatives to chemical control in the home garden.	6,000.
14.	Stephenson, G. R. and G. W. Anderson	University of Guelph	Reduction of herbicide drift in roadside spraying.	8,000.

Total research funds allocated by the Ontario Pesticides Advisory Committee in 1973-74 $ 100,000.

APPENDIX V. Progress reports (Abstracts) on projects funded by the Ontario Pesticides Advisory Committee, 1973-74

1) Allen, B. M., J. McLeod, G. W. Anderson, and G. R. Stephenson. Reduction of herbicidal drift in roadside spraying and application of 2,4-D in several crops.

The objective of this study was to obtain quantitative data to com-compare the effectiveness of various chemicals and nozzle types for the reduction of spray drift under actual spraying conditions in the field. At present, materials can be sold as drift reducing agents without first being proven to be effective. Because of the obvious hazard of damage to non-target vegetation via spray drift with phenoxy herbicides, it is important to be able to recommend materials or methods that can reduce the problem. It is equally important to discourage the use of materials that are being promoted as drift reducing agents if in fact they are ineffective for this purpose.

For the roadside spraying study, all experiments were conducted on an airport taxi strip. Six materials were evaluated: two invert emulsions (Bivert PH and Verton 2-D), two air emulsions (Foamspray and Accutrol), one particulating agent (Norbak) and one spray thickener (Lo-Drift). In all treatments 2,4-D amine was applied at a rate of 1 lb/acre, with a spray volume of 20 gpa, and a vehicle speed of 10 mph. Flourescene dye was applied as a marker in all treatments at a rate of ½ lb/acre. The sprayer used was commercially designed especially for roadside spraying. Each material evaluated was applied in strict accordance with the recommendations of the company involved. For each treatment, the spray vehicle was driven through a network of 12 poles 10 ft in height, assembled vertically in intervals in a line perpendicular to and including the intended target area. The target area was 25 ft in width and 5 ft in height immediately adjacent to the paved taxi strip. Each pole in the network extended 10 ft beyond each side of the target area. Each pole in the network contained 20 petri dishes, 5 thin layer chromatography plates, and four glass plates (coated with glycerin) for later analysis by cucumber root inhibition bioassay for 2,4-D, flourimetric analysis of flourescene, and gas liquid chromatographic analysis of 2,4-D,respectively. The cucumber root inhibition bioassay is now complete and the following results are indicated.

1. Detectable spray drift was intercepted at some points 10 feet above the ground and either 10 ft to the left or 10 ft to the right of the target area for the standard water spray and for all other treatments. Qualitative evidence of this was also obtained by visually examining each petri dish for deposition of flourescene under ultra violet light in the dark.

2. When the actual quantities of spray intercepted outside the target area were compared, definite differences between treatments were apparent.

    (a) Accutrol, Lo-Drift, and Verton 2-D resulted in significantly greater spray drift than the standard water spray, especially at higher wind velocities and would appear to be unacceptable with current application equipment and procedures.

    (b) Foamspray was not significantly different than water at comparable wind velocities and would also appear to be unacceptable with current application equipment and procedures.

(c) Bivert PH appeared to reduce spray drift compared to the standard water spray over a wind velocity range between 5 and 10 mph. This material could reduce the drift hazard as long as the normal precautions (vehicle speed, wind conditions, etc.) are followed.

(d) At low wind velocities (up to 5-6 mph), Norbak appeared to give no advantage over the standard water spray. However, the Norbak spray appeared to be quite stable and was as resistant to spray drift at a wind velocity of 19 mph as the standard water spray was at a wind velocity of 10 mph.

3. While some materials (Norbak and Bivert PH) may reduce spray drift, the reduction is not sufficient enough to relax normal spraying precautions without losing any advantage they may give. Other materials (Accutrol, Lo-Drift, Verton 2D or Foamspray) do not reduce and in fact may increase spray drift and thus should not be used without significant alterations in application equipment and/or procedures and subsequent evidence of effectiveness.

The test of drift with field spray equipment was conducted in a barley field at the Elora Research Station on June 20, 1973. An International Cub tractor with a 21 ft boom mounted on the front at a height of 20" was used to apply the treatments. All treatments were applied with a forward speed of 4 mph at right angles to the wind with the sprayer operating at 40 p.s.i. 2,4-D was applied at a rate of 8 oz/acre using the following methods.

1. TeeJet-8002 tips spaced 20" apart with water as the carrier. Rate of application was 20 gpa.
2. TK2 Flood Jet tips spaced 40" apart, mounted vertically, spraying forward with water as the carrier. Rate of application was 20 gpa.
3. TK2 Flood Jet mounted the same as in 2, with water plus 2 pints of Amchem Lo-Drift per 100 gallons of water used as a carrier. Rate of application was 20 gpa.
4. Delavan air induction nozzles DF 6-65°. Eight nozzles were used, spaced 20" apart. Water plus 3 qts of Velsicol's Accutrol per 100 gallons of water was used as the carrier. Rate of application 40 gallons/acre.

Three runs were made with each treatment. Plates and slides were set at a height of 12" and at soil level in the sprayed swath. A 10 ft pole was placed 2, 12 and 22 ft down wind from the end of the spray boom. Plates and slides were mounted at 2.5, 5.0, 7.5 and 10.0 ft heights on each pole.

Results and Conclusion

1. Drift of 2,4-D was indicated with all treatments at all points on the collecting poles. Further studies of this type should include taller poles spaced further from the sprayed area.
2. Our detection methods did not indicate any differential interception of 2,4-D by barley among the treatments tested. Possibly other methods should be used to collect this information.
3. The Flood Jet tips as operated in this test gave more drift than the 8002 TeeJet or the foam application. The flood jets were sprayed horizontally and the others vertically which could be a partial explanation for the increased drift. Further tests with Flood Jets should include studies on the effect of nozzle height and angle at which the spray is delivered to the target.

4. The addition of the thickening agent (Lo-Drift) did not greatly reduce the drift from the Flood Jet tips.
5. The applications with the TeeJet tips and with the foam (Accutrol) gave the least drift in this test. The foam treatment gave slightly less drift than the standard TeeJet tips. Since a smaller orifice for the Delavan nozzles could not be obtained in time for the test, the rate of spray per acre was higher with these nozzles than with the others and this could account for the slight decrease in drift compared to the 8002 tips.
6. The wind velocity was 5-10 mph when the TeeJet applications were made and 8 to 17 when the other applications were made. With the TeeJet application there was increased drift with increasing wind velocity. The foam application seemed to be less dependent on the wind. The effect of wind velocity on the drift from the Flood Jets was quite variable. Further tests should include more replication over a wide range of wind speeds.

2) Beyer, M. G., J. E. Butcher, and C. D. Fowle. The response of bacteria, algae, and invertebrates in small ponds to applications of mosquito larvicides.

Studies to date have revealed some of the biological and chemical changes taking place during the initial phases of the establishment of a diverse aquatic habitat and measured their response to the application of Dursban and Abate at levels of 0.1 to 10.0 ppm. Some of the chemical parameters, notably phosphate,and Kjedahl nitrogen responded to the application of 1 ppm Abate or Dursban with what seem to be transitory increases or decreases in concentrations. They are apparently not sustained beyond the experimental period indicated although this is in need of verification since the fluctuations do not necessarily exhibit successive decreases in intensity. The chemical changes may be, but again this has not been proven, a manifestation of the initial changes in bacterial numbers observed when the water is treated with 0.1 ppm Dursban. This would seem to be a logical interpretation, however, for during the early stages of succession in these ponds, bacteria are probably the only living components of the system. The chemical changes may provide an example of an indirect or secondary response initiated at a point in time figuratively remote from the time of application of the pesticide.

With some knowledge of this system behind us, it should be possible not only to verify whether these events are related but to establish whether responses, such as temporary repressions of bacterial numbers can indeed have secondary or even more remote effects of any consequence.

3) Brown, J. R. The effect of O,O-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate (Dursban) on aquatic microflora.

Laboratory studies indicated that Dursban could affect the growth of algae. When incorporated into the culture medium at 10 and 100 ppb Dursban had definite growth effects on *Chlorella vulgaris*. Growth effects on *Ankistrodesmus falcatus acicularis* were apparent at 200 ppb. In field studies at Baie du Dore, Dursban at 1.2 ppb had marked growth effects on several types of phytoplankton. Concentrations of more than 24 ppb Dursban retarded growth rates of all phytoplankton. The effect was still apparent 17 days after the initial Dursban application.

It would appear that Dursban in very low concentrations can have an effect upon phytoplankton in fresh water and this effect is present for a

considerable period of time following the initial application. The effect is variable and dependent upon the natural growth cycle of the phytoplankton concerned but most marked during the natural growth phase. It would appear that Dursban applied at the beginning the black fly season would not have as great an effect as would occur if it were applied during the early and late summer months. However, it does need to be confirmed by field experiments under field conditions. (Abstracted by CRH).

4) Corbet, P. S., S. Smith, R. G. Downer, and R. Wright. Mosquito control in Ontario.

The research project on surveying the situation with regard to mosquito control in Ontario was initiated early in 1974 jointly by the University of Waterloo and the University of Guelph at the request of the Ontario Pesticides Advisory Committee. A detailed plan of the project has been developed and the necessary assistance is presently being recruited. (Abstracted by CRH).

5) Corke, C. T. Interactions of triazine herbicides with soil and freshwater environents.

Cyanazine, cyanazine(amide),cyanazine (acid), hydroxycyanazine (acid), atrazine, simazine and cyprazine were found to be not inhibitory to the mineralization of carbon and nitrogen nor the biological transformation of ammonium nitrogen to nitrate nitrogen in soil and water systems. Preliminary studies on the nitrogen fixation process by blue-green algae indicate inhibition by the phytoxic molecules. The influence of these compounds on blue-green algae is being studied.

While most s-triazine herbicides are detoxified chemically in the environment by chemical hydroxylation of the 2-carbon of the ring, such is not the case with cyanazine. The position of chemical transformation is the cyano group of the 4-carbon substituent, and involves a chemical hydrolysis to a cyanazine-amide derivative. This does not appear to occur in soils, but does occur under acidic conditions when the herbicide is adsorbed on the surface of clay minerals. In soils microbial transformations are the main mechanisms of detoxication. A variety of compounds has been identified, including atrazine. Shell Laboratories have reported that the main residue of the metabolism in soil of cyanazine is a hydroxylated cyanazine acid residue, this has been shown to be an artifact of their soil extraction procedures.

The adsorption of atrazine, simazine, cyanazine and cyanazine-amide on clay surfaces is similar, and is a function of their respective pK_a. The biological transformation of cyanazine produced compounds which exhibit greater adsorption to clays over a wider pH range. No detectable movement of these compounds was apparent in soils under water flow. The influence of organic matter, amounts and type on adsorption of these compounds is under investigation.

6) Fletcher, R. A. Effect of carbofuran on the physiology of plants.

The effect of carbofuran on the physiology of corn and radish plants was examined in both short and long term experiments conducted under strictly controlled environmental conditions. In short term experiments corn was germinated in petri dishes either directly in carbofuran or after pretreatment.

In both instances carbofuran stimulated root growth 4 days after germination. However even if the root weight of treated plants were 20% greater than the controls these values were not significantly different probably due to the inherent variation in corn. The same results were obtained in long term experiments when corn was grown for 6 weeks in turface, an inert material. Shoot growth was also stimulated by carbofuran but the results were not significantly different than the controls. It was observed that the growth of radish was more uniform than corn and was therefore used in long term experiments. Radish was grown to maturity in turface either with continuous treatment with carbofuran or after pretreatment. In both instances carbofuran stimulated root growth and the values were significantly higher than the controls. It must be pointed out that the experiments with corn have been done several times. In case of radish, although there were many replicates the experiment has only been done once and before any firm conclusions are drawn the experiments will have to be repeated.

7) Fowle, D. and J. Jacks. A preliminary investigation on the responses of sparrows to granular formulations of pesticides.

The investigation reported here was undertaken in June, 1973, at the invitation of the Pesticides Advisory Committee of the Ontario Ministry of the Environment. Its purpose was to explore the possibility that wild birds might eat granular formulations of pesticides. It seemed possible that birds, such as some of the sparrows and other species which feed on the ground, might pick up granules when searching for seeds or grit. Irregular granules made of clay, diatomaceous earth or other hard material might be ingested as a substitute for grit, but it seems unlikely that birds, highly specialized for feeding on seeds and invertebrates, would mistake granules for food and eat them in quantities sufficient to poison them.

We were, however, encouraged to proceed with some experiments when we found from a search of the literature that the problem had been almost completely neglected in the studies of the effects of pesticides on birds. Moreover, in response to enquiries directed to the principal research groups investigating the impact of pesticides on birds, we were informed by Dr. Lucille Stickel (Director, U.S. Fish and Wildlife Research Center, Laurel, Maryland) that "the question is open and unsettled but well worthy of attention". Mr. James Keith (Chief, Section of Pesticide-Wildlife Ecology, U.S. Fish and Wildlife Service Laboratory, Denver, Colorado) also commented on the necessity for investigation and told us that shorebirds feeding in rice fields in Texas had been found to eat granules of Furadan which had apparently killed them. This opened up a new possibility in view of the use of granular mosquito larvicides on wetlands where shorebirds might be present.

Conclusions and Recommendations

Conclusions:

In the first five months of work on this project we have reached the following conclusions:

1. Little or no work has been done elsewhere on the feeding responses of birds to granular formulations of pesticides.
2. There is no clear evidence that birds have been harmed by actually eating granular formulations except for the case of shorebirds eating Furadan in Texas. On the other hand, so little is known about the problem it would be premature to draw general conclusions.

3. A number of experiments with caged sparrows exposed to foods containing granules suggest that very few granules were eaten under conditions of captivity. This is in contrast to work with bobwhite quail where substantial quantities were consumed.

4. It appears that a chromic oxide marker incorporated into granules would enable us to trace the consumption of granules by birds held in large cages in reasonably natural conditions or, possibly, even to monitor consumption by free ranging birds.

Recommendations:

1. Now that a promising tracer is available we should explore the possibility that experimental batches of granules could be made for us so that chromic oxide could be incorporated directly into the granules without altering their appearance. Such granules would enable us to conduct closely controlled cage experiments and realistic field experiments.

2. The possible hazard to shore birds might be explored by scattering labelled granules in areas frequented by migrating shore birds in spring and fall and by resident species in summer. Consumption could be traced by analysis of faeces or by collecting a few birds and examining their digestive tracts.

8) Gillespie, T. J., Sutton, J. C. and W. J. Langenberg. Reduction of fungicide usage on vegetable crops by scheduling sprays according to weather data.

During the growing season of 1973, a very complete set of field data were obtained concerning the effect of weather and fungicide applications on carrot leaf blights caused by Alternaria dauci or Cercospor carotae. Previous reference to the literature had revealed that the following weather variables were most influential on these diseases: temperature, humidity, duration of leaf wetness, wind, and sunshine. These variables were monitored continuously from early June to mid-October at the test site on the Ontario Ministry of Agriculture and Food Muck Research Station at Bradford, Ontario. In addition, the air was continuously sampled to obtain the hour-by-hour trends in airborne spore loads and the spread of disease was recorded in terms of percentage leaf area blighted at regular intervals through the season.

The first Alternaria dauci spores appeared in our trap on July 1st and commercial carrot growers in the area began their weekly fungicide spray program in the first or second week of July. However, in our unsprayed plot which was surrounded by nearby large commercial carrot fields, a very susceptible variety showed less than 2% diseased leaves until the first week of August when an increase to 12% blighted leaf area occurred. A moderately susceptible cultivar showed less than 1% disease at this time. This data and data from 1972 suggest that the regular spray program in the marsh is often begun too early.

We also maintained two plots that were sprayed with a fungicide. The first was treated weekly beginning July 18 to mimic the common commercial practice in the area, although some growers had by this time already applied three sprays. The second was sprayed according to some general rules we had derived from 1972 experiences concerning the reaction of carrot blight to the weather. On Oct. 12, when the commercial harvest was well underway, the following data were obtained for the highly susceptible carrot cultivar:

Treatment	% Leaf Area Blighted	Total Sprays Used
No fungicide	75	Nil
Weekly fungicide	24	7
Fungicide timed by weather	7	3

It is seen that proper fungicide timing not only reduced the total chemical load but improved the disease control.

9) Inculet, I. I. Electrostatic application of pesticides on orchards and field crops.

The research team has carried out a series of preliminary field (Guelph Experimental Orchard) and laboratory (artificial tree at U.W.O.) experiments to determine the effectiveness of the new method which utilizes the Faraday Cage effect of the tree canopy.

Several kinds of modified spray equipment were used to spray both powder and liquid aerosols which were electrically charged. Various tracers enabled determination of the average deposition per cm^2 on both sides of the leaves. The sample leaves were taken from 72 standardized locations (inside and on the surface of the tree canopy) orientated in the same way relative to the wind direction. As seen from the synopsis of the field experiments carried out from June 15 to October 12, the electrified particles do achieve a better coverage on both sides of the leaf.

These preliminary experiments have utilized modified paint spraying equipment which has not been specifically designed to achieve maximum electric charging, optimum particle size or suitable spray patterns. In order to demonstrate the full potential of the new method, the investigators believe that a specially designed apparatus must be built to: atomize and effectively charge the pesticide in dry or liquid form; produce uniform size liquid particles; prevent the agglomeration of solid particles; and be readily portable and suitable for mounting on and operation from a tractor.

New apparatus is currently being designed to be ready for the first spray application next spring.

10) MacKay, D. The rate of evaporation of the pesticides parathion and diazinon under Ontario climatic conditions.

The approach adopted was to undertake first an extensive literature survey. It was then decided to design and construct an experimental evaporation apparatus and with it obtain evaporation rate data under conditions when both the rate of loss of pesticide from a substrate could be determined analytically and the evaporated pesticide collected in a gas scrubber and analysed. In this way the evaporation rate can be determined unequivocally and competitive degradation processes quantified. The apparatus and its performance are described.

It is important to ensure that the evaporation apparatus will operate under conditions which will simulate those in the environment and accordingly evaporation rates were determined for naphthalene plates in the apparatus in the environment enabling proper simulation conditions to be selected. This work, its mathematical background, and the conditions selected are described in detail.

Evaporation rates were determined for pure parathion and diazinon. These agree reasonably well with predicted values from the published vapour pressures. These evaporation rates represent the maximum potential rates and it is estimated that they exceed the actual environmental application evaporation rates by a factor of about 100. The practical implications of this observation are discussed.

Recommendations are made for the next stage of this work which will include evaporation rate determinations from substrates such as typical Ontario soils or foliage under various relevant temperature humidity Ontario soils or foliage under various relevant temperature humidity and ground water content conditions.

11) Mayfield, C. I. Effects of the dipyridyl herbicides paraquat and diquat on non-target organisms.

The effects of the dipyridyl herbicides paraquat and diquat on non-target microorganisms were examined. Paraquat applied to soil was concentrated in the surface layer. Organic material and clay minerals increased the adsorbing capacity of the soil. At normal levels of application, inhibitory effects on straw decomposition and cellulose degradation processes were found. The bacteria and fungi involved in these processes were inhibited. Asymbiotic N_2-fixation in soil was inhibited by high levels of paraquat due to the inhibition of N_2-fixing Azotobacter and Clostridium species. Symbiotic N_2-fixing bacteria (Rhizobium) were inhibited in pure culture. Many soil bacteria were inhibited at low paraquat levels but others tolerated very high concentrations. The inhibitory effect was bacteriostatic, not bactericidal. Paraquat was degraded chemically and biologically in soils under aerobic or unaerobic conditions.

Initial investigations of the effects of diquat in an aquatic ecosystem showed that diquat moved slowly through the sediment and from the sediment to the water and vice versa. Bacteria isolated from the system showed variable responses to different concentrations of diquat. Breakdown of diquat in water and sediment was slow.

Thus both diquat and paraquat had significant effects on non-target microorganisms and soil and water processes.

12) McEwen, F. L. Control of the onion maggot, Hylemya antiqua (Meigen) by use of the sterile male technique.

Progress under the objectives outlined in the proposal is as follows:
Objective 1. To determine the age and stage at which sterilization by Cobalt-60 is most successful without adverse physical effects on the fly.
Conclusion: Pupae 6 days out of cold storage, dosage of 4 krads for the white-eyed mutant strain.

Objective 2. To assess relative competitiveness of normal and sterilized flies.
Conclusion: Under laboratory conditions, the white=eyed strain when sterilized under conditions in 1 (above) are as competitive as unsterilized.

Objective 3. To determine flooding ratio required.
Conclusion: A 9:1 ratio should result in 90% reduction in egg hatch.

Objective 4. To determine release procedure.
Conclusion: The white-eyed strain is unsuitable for release. The red-eyed strain, if unaffected by sterilization, should disperse well if released at sites no more than 600 feet apart.

Objective 5. To determine optimum time for release.
Conclusion: In a pattern to coincide with emergence pattern of adults from the overwintered generation.

Objective 6. To determine the number of wild flies in a specified area, the Holland Marsh.
Conclusion: The overwintered generation of pupae would produce 54 million adults in 1972, 41 million in 1973.

Objective 7. To conduct a small release in 1973.
Result: When 110,000 sterilized white-eyed flies were released in a 4-acre area calculated to produce approximately 4,000 flies, percent hatch of eggs in the release area was 61.4 compared to 80.17 in the control area. It is concluded that the white-eyed flies are not competitive with the wild red-eyed flies.

Objective 8. To follow this in succeeding years with release in the Holland Marsh and subsequently in other areas if successful.
Plans: To release sterilized red-eyed flies in the Keswick marsh in 1974. This marsh had 184 acres planted to onions in 1973 and is estimated to produce 600,160 flies in 1974.

13) Ontario Fruit and Vegetable Growers Association. Microplot and large-scale field trials on the control of the dark-sided cutworm attacking vegetables grown in mineral soils in Ontario using pre- and post-planting insecticide treatments.

With the banning of DDT in Ontario in 1970, it became apparent that there were no effective insecticides available for control of subterranean cutworm attacking vegetables. Initially emphasis was placed on control of the redbacked and black cutworms attacking vegetables (onions, lettuce, carrots). However, cutworm problems have also appeared with other vegetables grown in mineral soils. In 1973 a joint program was developed between the Canada Department of Agriculture, London, Ontario, and the Ontario Ministry of Agriculture and Food, Simcoe, Ontario and the University of Guelph with support from the Ontario Pesticides Advisory Committee to determine effective insecticides for controlling cutworms attacking vegetables grown on mineral soils. Because of limitations of time, staff, and funds, it was possible to conduct studies on only a limited number of crops with only one species of cutworm, the dark-sided cutworm *Euxoa messoria* (Harris). The studies included assessments of efficacy, phytotoxicity, and residues. Microplot field trials at the London Research Institute were done using 4 insecticides (chlorpyrifos, leptophos, N-2596, and WL 24073), with carbaryl as a "standard." Only chlorpyrifos and leptophos were included in large-scale field trials. Residue analysis on the microplot samples were done by the London Research Institute and on the large-scale plots by the Provincial Pesticide Residue Testing Laboratory at the University of Guelph.

a) Peppers

Since earlier microplot studies had demonstrated that either chlorpyrifos or leptophos would provide effective cutworm control at 1-2 lb AI/acre, when applied as preplanting treatments, 1973 studies emphasized post-planting treatments. However, large-scale field trials using preplanting treatments were also done where possible. Where feasible portable microplots were used which were infested with laboratory-reared 4th instar larvae in order to obtain information in the event that a natural infestation did not occur. On light mineral soils adjacent to the tobacco-growing areas in southwestern Ontario, rye is often seeded after harvest for cover. This is ploughed under in the spring and the land is planted to vegetables. The dark-sided cutworm thrives in this situation. One portable microplot test involving a large-scale rye

treatment with chlorpyrifos at ½ lb AI/acre indicated that the insecticide caused 100% mortality of the laboratory-reared cutworms in 48 hr., while the controls remained alive. No parallel natural infestation occurred. However, sufficient data is available from earlier studies on tobacco to indicate that where rye is used as a cover crop, either chlorpyrifos or leptophos will provide effective cutworm control.

In large-scale field trials using preplanting soil treatments of chlorpyrifos and leptophos, no natural cutworm infestations occurred. However, useful data on residues and phytotoxicity were obtained. No residues of chlorpyrifos, leptophos, or their breakdown products were found on the peppers at harvest. None of the treatments caused significant phytotoxicity.

The effectiveness of post-planting insecticide treatments for controlling cutworms attacking peppers was assessed in both microplot (London) and large-scale field trials (Simcoe). Results of the microplot tests indicated that chlorpyrifos, and WL 24073 provided effective control at 0.5 and 1.0 lb AI/acre. N-2596 and leptophos at 0.5 and 1.0 lb AI/acre were as effective as carbaryl at 2.0 lbs. Control with carbaryl in this experiment was better than usual probably because much of the cutworm feeding occurred above ground. No significant residues of chlorpyrifos, leptophos, their oxons, or N-2596 were detected at harvest. None of the treatments were phytotoxic. Large-scale field trials were done with chlorpyrifos and leptophos only. Results of these tests closely paralleled those obtained in the microplot studies. Both insecticides were effective. No residues of chlorpyrifos were detected at either sampling date. However, traces of leptophos were detected at the first sampling. None of the treatments were phytotoxic.

b) Cucumbers

In large-scale field trials conducted at Simcoe to assess the effectiveness of preplanting treatments of chlorpyrifos and leptophos, no damage was apparent in any of the plots including the control although cutworms were present in that field. However, useful residue data was obtained which indicated that no residues of chlorpyrifos, leptophos, or their degradation products were present in the cucumbers at harvest.

The effectiveness of post-planting treatments was assessed in both microplot (London) and large-scale field trials (Simcoe). The cutworm larvae, although present in the plots at a density of 2/plant caused only slight damage to the cucumbers in the control and carbaryl treated plots. No damage occurred in plots treated with chlorpyrifos, leptophos, N-2596, or WL 24073. No residues of chlorpyrifos, leptophos or N-2596 were detected in cucumbers at harvest. Phytotoxicity studies indicated that neither N-2596 nor chlorpyrifos were phytotoxic at 0.5 lb AI/acre. Leptophos and carbaryl showed minor evidence of phytotoxicity at 7 days, but the plants had recovered after 14 days. WL 24073 was highly phytotoxic. In large-scale field trials at Simcoe similar results were obtained. No cutworm damage occurred in any of the experimental plots including the contol plot. No significant residues of chlorpyrifos or leptophos were detected on the cucumbers at harvest. Chlorpyrifos was not phytotoxic, but leptophos at 2.0 lb AI/acre caused minor damage. However, assessment of yield of one row of the leptophos-treated plot failed to show any differences.

c) Tomatoes

In large-scale field trials conducted at Simcoe to assess the effectiveness of preplanting treatments of chlorpyrifos and leptophos for cutworm control no damage was apparent in any of the plots including the control. Residue analysis indicated trace amounts of chlorpyrifos in tomatoes at harvest and small amounts of chlorpyrifos TCP. No detectable residues of leptophos were found.

In microplot field trials at London, using post-planting treatments, no cutworm damage occurred in the plots although they were infested with larvae at a density of 2/plot. No residues of chlorpyrifos, leptophos, or N-2596 were detected in tomatoes at harvest. None of the experimental insecticides caused phytotoxicity. In large-scale tests at Simcoe only slight damage occurred in the control portable microplots and none in the treatments of chlorpyrifos and leptophos. No significant cutworm damage from natural infestation occurred in the large plots. Negligible levels of chlorpyrifos were found in harvest samples. The first sample of tomatoes contained small amounts of leptophos and leptophos BCP at harvest at the 2 lb rate. No residues were detected in the second sample.

d) Potatoes

In large-scale field trials at Simcoe to assess the effectiveness of preplanting treatments of chlorpyrifos and leptophos for cutworm control, no damage occurred in any of the plots including the control. Chlorpyrifos and its degradation products were found in the potatoes at both the first and second sampling dates. Low levels of leptophos were also present in potatoes at the first sampling date.

In microplot field trials at London using post-planting treatments, no cutworm damage occurred in the plots, either treated or untreated, although they were infested with 2 larvae/plant. No residues of chlorpyrifos or its oxon were detected in the potatoes at harvest. A trace of leptophos was detected in the potatoes. No residues of N-2596 were present. None of the insecticide treatments was phytotoxic. Similar results were obtained in large-scale field trials at Simcoe with no cutworm damage or phytotoxicity occurring. No residues of chlorpyrifos or leptophos were found in potatoes at harvest.

e) Crucifers

Although major emphasis in 1973 was placed on controlling cutworms attacking peppers, cucumbers, potatoes, and tomatoes, it was also possible to conduct large-scale field trials on a variety of cruciferous crops at Simcoe. Tests were conducted on cabbage, chinese cabbage, broccoli, rutabaga, brussels sprouts, and cauliflower using chlorpyrifos and leptophos as post-planting treatments at 1 and 2 lbs AI/acare. While some cutworm damage was evident on some of the crucifers, a sufficient amount could not be found to justify damage assessment. No evidence of phytotoxicity to any of the crucifers was observed. No residues were detected in cabbage, broccoli, and rutabaga. However, significant levels of leptophos were found on chinese cabbage, particularly the WP formulation. Rapid germination and growth of chinese cabbage probably accounts for the residues found; the periods between treatment (12/7/73) and harvest (3/8/73: 20/8/73) were only 22 and 39 days respectively. The plants were at least four inches high at treatment, while the other crucifers treated were still in the cotyledon stage.

f) Host plant preference of the dark-sided cutworm

A major difficulty in conducting studies on cutworm control is that infestations are unpredictable and never seem to occur in experimental plots although the grower's field next door may be wiped out. This was one reason for the development of the microplot technique at London when the plots were infested with laboratory-reared cutworms of the desired species. In addition, at Simcoe in 1973 an infestation of the dark-sided cutworm (Table 6) was present in the field used for the large-scale field trials, as shown by the damage occurring to peppers, and also by field collections of larvae made by those involved. Thus the lack of damage in the control plots to tomatoes, potatoes, and cucumbers, both in the microplots at London and the large-scale field trials at Simcoe was surprising. Past evidence has indicated that in light mineral soils, particularly adjacent to tobacco-growing areas, the dark-sided cutworm is the major species. To determine if the dark-sided cutworm had distinct host plant preferences a microplot study was set up at London on available crops utilizing laboratory-reared larvae which were introduced into the plots at a density of 10/plant. The results clearly indicated a host-plant preference (Table 26) with the order of preference being tobacco > peppers = lettuce. The larvae did not feed on potatoes or tomatoes and subsequent examination indicated that they starved to death. These results served to explain the lack of efficacy data on some of the crops tested. However, later in the season cutworms collected from a potato field in the Alliston area where they were causing heavy damage were reared to adults and sent to the Entomology Research Institute for identification. They were identified as dark-sided cutworm (Table 6). Thus it is possible that not only does host plant preference enter the picture but also stage of plant development. Obviously more work in this area is required.

g) General conclusions

The massive effort put into the cutworm/vegetable program in 1973 by CDA and OMAF with financial assistance from both industry and the Ontario Pesticide Advisory Committee demonstrates the magnitude of the problem resulting from the arbitrary banning of DDT for cutworm control on vegetables in 1970. Other vegetable and field crops still require assessment. Similar problems are arising with other pests, e.g. flea beetle, which attack a wide variety of host plants and the amount of data required for efficacy, phytotoxicity, and residue analysis is staggering.

Several conclusions can be drawn from the 1973 program. While the amount of efficacy obtained was limited due to host plant preference of the dark-sided cutworm, excellent efficacy data was obtained on peppers both in microplots and large-scale field trials which indicates that chlorpyrifos and leptophos will provide effective control as post-planting treatments. It may be assumed that, with other crops not preferred by the dark-sided cutworm, the damage will be caused by the 2 other species of major importance in Ontario, i.e. the redback and black cutworms. Numerous other studies at London have demonstrated that leptophos and chlorpyrifos are effective against these species. From an efficacy point-of-view there should be no problem in having these materials registered for use as post-planting treatments.

Past studies have indicated that chlorpyrifos and leptophos can be phytotoxic to some crops with the EC more toxic than the WP. It was expected that crops such as peppers would be highly susceptible to damage, but no phytotoxicity was apparent to peppers, tomatoes, potatoes, or crucifers with either material. Leptophos was slightly phytotoxic to cucumbers both in microplot and large-scale field trials.

Residue studies indicated that post-planting treatments at the rates used would be unlikely to result in significant residues in peppers, cucumbers, tomatoes, potatoes and crucifers with the exception of chinese cabbage.

Microplot studies indicated that two experimental insecticides were effective against cutworms as post-planting treatments. Stauffer N-2596 has consistently shown good results against cutworms when applied as a post-planting treatment and appears to be the least phytotoxic of all the materials tested even when used as EC. Microplot residue data would indicate that it is unlikely to cause residue problems. WL 24073 also was effective against the cutworm and provided secondary control of potato beetle for several weeks. It was however highly phytotoxic to cucumbers (and to tobacco). No residue studies were done with this material but the observations on potato beetle control indicate that it is moderately persistent. All materials tested in microplots were more effective than carbaryl.

Because of the sporadic nature of cutworm outbreaks and the importance of proper timing of applications of short-residual insecticides such as leptophos and chlorpyrifos, major emphasis was placed on post-planting rather than preplanting treatments. However, where rye is grown in rotation with vegetables as occurs with tobacco the results showed that a preplanting rye treatment would provide effective control of the dark-sided cutworm. Results of the large-scale field tests on preplanting soil surface applications of chlorpyrifos and leptophos were hampered by the lack of a natural population. However, other studies have indicated that such treatments will provide effective control of the dark-sided cutworm. None of the preplant treatments were phytotoxic. Residue studies indicated no problem with peppers and cucumbers. Traces of chlorpyrifos were found on tomatoes, and both chlorpyrifos and leptophos were found in potatoes.

Where parallel studies were conducted results of the microplot and large-scale field trials were in excellent agreement.

14) Orlob, G. B. Alternative methods to chemical control in the home garden.

Alternatives to Chemical Control:

1. Short-lived botanical insecticides (pyrethrum) controlled a number of pest insects.
2. A microbial (Bacillus thuringiensis) insecticide was effective against all caterpillars.
3. Good results were obtained with detergent/soap sprays against pests, insects and mites.
4. Hand-picking or simply hosing off pest insects was successful at several sites.
5. Hand-weeding, if properly done, quite effective. Spot-treating lawn weeds as effective as blanket spraying whole lawn with herbicide.
6. Disease control - sulphur controlled mildews on a number of plants.

Not effective:

1. Companion plantings. Claims to keep away aphids and other insects by planting chives, onions, garlic, and other herbs in the garden could not be substantiated.
2. Herbal sprays. Extracts prepared from onions, garlic, and other herbs did not affect aphids and caterpillars.
3. Light traps. Not effective against most garden pests.

Conclusion:

1. "Biological" methods as successful as chemical approach if properly applied.
2. Even in the absence of all controls no serious problems developed.
3. Further studies needed.